

Applicant: Wasserscheid et al.
Filing Date: March 11, 2004

Amendments to the Claims

Docket No. VSKW-1

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Claims

We claim the following:

1) (Canceled)

2) (Currently Amended) A process for ~~using a the~~ compound of the Formula 1 ~~in a process~~,

(cation)(R'SO₄)

Formula 1

comprising the step of: employing the compound as a solvent, or solvent additive in a chemical process; employing the compound as an extraction solvent for a material separation; or employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit, wherein:

R' is selected from the group consisting of a linear or branched, saturated or unsaturated, aliphatic or alicyclic, functionalized or non-functionalized alkyl radical with 3-36 carbon atoms, wherein R' is optionally functionalized with one or more X groups; X is selected from the group consisting of an -OH, -OR'', -COOH, -COOR'', -NH₂, -SO₄, -F, -Cl, -Br, -I or -CN; and R'' is selected from the group consisting of a branched or linear hydrocarbon chain with 1 - 12 carbon atoms;

the compound has a melting point of less than 100° C; and

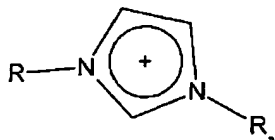
the cation is a nitrogen-containing cation selected from the group consisting of a quaternary ammonium cation, an imidazolium cation, a pyridinium cation, a pyrazolium cation, a phosphonium and a triazolium cation.

3) (Currently Amended) The ~~method~~ process of claim 2, wherein the cation is selected from the group consisting of:

a) quaternary ammonium cation with the general formula (NR₁R₂R₃R)⁺;

b) phosphonium cation with the general formula (PR₁R₂R₃R)⁺;

c) imidazolium cation with the general formula



in which the imidazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group;

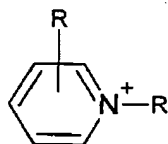
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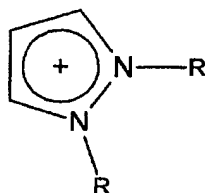
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d) pyridinium cation with the general formula



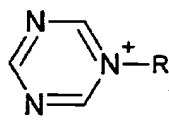
in which the pyridine core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-
5 aryl-C₁-C₆ alkyl group;

e) pyrazolium cation with the general formula



in which the pyrazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-
10 aryl-C₁-C₆ alkyl group; and

f) triazolium cation with the general formula



in which the triazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-
15 aryl-C₁-C₆ alkyl group; wherein

g) the radicals R¹, R², R³ are selected independently at each occurrence from the group consisting of:

i) hydrogen;

ii) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1
20 to 20 carbon atoms;

iii) heteroaryl groups, heteroaryl-C₁-C₆ alkyl groups with 3 to 8 carbon atoms in the heteroaryl radical and at least one heteroatom selected from N, O and S which is optionally substituted with at least one group selected from C₁-C₆ alkyl groups and/or

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halogen atoms;

iv) aryl, aryl-C₁-C₆ alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C₁-C₆ alkyl group and/or a halogen atom; and

h) the radical R is selected from the group consisting of:

i) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

ii) heteroaryl-C₁-C₆ alkyl groups with 3 to 8 carbon atoms in the aryl radical and at least one heteroatom selected from N, O and S, which is optionally substituted with at least one C₁-C₆ alkyl group and/or halogen atom; and

iii) aryl-C₁-C₆ alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C₁-C₆ alkyl group and/or halogen atom.

4) (Currently Amended) The ~~method~~ process of claim 2, wherein the anion has an empirical formula selected from the group consisting of C₄H₉SO₄, C₈H₁₇SO₄ or C₁₂H₂₅SO₄.

5) (Currently Amended) The ~~method~~ process of claim 2, wherein the compound of the Formula 1 has a melting point of less than 75° C.

6) (Currently Amended) The ~~method~~ process of claim 2, wherein the compound of the Formula 1 has a melting point of less than 50° C.

7) (Currently Amended) The ~~method~~ process of claim 2, wherein (R'SO₄) is an alkyl sulfate ester, wherein the alkyl moiety is selected from the group consisting of butyl, octyl, 2-ethylhexyl, and dodecyl; and the ~~method~~ process comprises the step of: employing the compound as a solvent, solvent additive, ~~or in a chemical process; employing the compound as an extraction solvent in a material separation; or employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit; or employing the compound as a phase transfer catalyst.~~

8) (Currently Amended) The ~~method~~ process of claim 7, wherein the cation is a nitrogen containing cation selected from the group consisting of 1-ethyl-3-methylimidazolium, 1-butyl-3-methylimidazolium butyl, 1-hexyl-3-methylimidazolium, 1-octyl-3-methylimidazolium, 1-decyl-3-methylimidazolium, 1-dodecyl-3-methylimidazolium, 1-butyl-pyridinium, trimethyldecylammonium, trioctylmethylammonium, trimethyldecylammonium, and trihexyltetradecylphosphonium.

9) (Currently Amended) The ~~method~~ process of claim 2, wherein the cation is a nitrogen

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containing cation selected from the group consisting of 1-ethyl-3-methylimidazolium, 1-butyl-3-methylimidazolium butyl, 1-hexyl-3-methylimidazolium, 1-octyl-3-methylimidazolium, 1-decyl-3-methylimidazolium, 1-dodecyl-3-methylimidazolium, 1-butyl-pyridinium, trimethyldecylammonium, trioctylmethylammonium,
5 trimethyldecylammonium, and trihexyltetradecylphosphonium; and the method process comprises the step of: employing the compound as a solvent or, solvent additive ~~, or~~ in a chemical process: employing the compound as an extraction solvent for a material separation; ~~or~~ employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit; or employing the compound as a phase transfer catalyst.

10 10) (Currently Amended) The method process of claim 2, wherein the ~~compound of the Formula 1 is used in process~~ is a reaction catalyzed by a transition metal; and the method process further comprises the step of: employing the compound as a solvent or, solvent additive ~~, or~~ in a chemical process: employing the compound as an extraction solvent for a material separation; ~~or~~ employing the compound as a heat carrier, or heat carrier additive in a heat
15 exchange unit; or employing the compound as a phase transfer catalyst.

11) (Currently Amended) The method process of claim 10, wherein the ~~compound of the Formula 1 is used in the chemical process~~ is selected from the group consisting of a hydroformylation reaction, a hydrogenation reaction, oligomerization reaction, esterification reaction, isomerization reaction ~~or~~ and amide bond-forming reaction.

20 12) (Currently Amended) The method process of claim 2, wherein the ~~compound of the Formula 1 is used in chemical process~~ is a reaction catalyzed by an enzyme or biocatalyst; and the method process further comprises the step of: employing the compound as a solvent, or solvent additive ~~or~~ in a chemical process; ~~or~~ employing the compound as an extraction solvent for a material separation; employing the compound as a heat carrier, or heat carrier
25 additive in a heat exchange unit; or employing the compound as a phase transfer catalyst.

13) (Currently Amended) The method process of claim 12, wherein the ~~compound of the Formula 1 is used in chemical process~~ is an oligomerization reaction, C-C bond-forming reaction, esterification reaction, isomerization reaction, or amide bond-forming reaction.

14) (Currently Amended) The method process of claim 2, wherein the compound of the Formula
30 1 is substantially hydrolytically stable in neutral aqueous solution (pH = 7) up to 80° C.

15) (Currently Amended) The method process of claim 2, wherein the compound of the Formula

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1 has a melting point of less than 25° C.

16) (Currently Amended) The ~~method~~ process of claim 2, wherein the compound is selected from the group consisting of:

- a) 1-ethyl-3-methylimidazolium butyl sulfate;
- 5 b) 1-ethyl-3-methylimidazolium octyl sulfate;
- c) 1-ethyl-3-methylimidazolium 2-ethylhexyl sulfate;
- d) 1-ethyl-3-methylimidazolium dodecyl sulfate;
- e) 1-butyl-3-methylimidazolium butyl sulfate;
- f) 1-butyl-3-methylimidazolium octyl sulfate;
- 10 g) 1-butyl-3-methylimidazolium 2-ethylhexyl sulfate;
- h) 1-butyl-3-methylimidazolium dodecyl sulfate;
- i) 1-hexyl-3-methylimidazolium butyl sulfate;
- j) 1-hexyl-3-methylimidazolium octyl sulfate;
- k) 1-hexyl-3-methylimidazolium 2-ethylhexyl sulfate;
- 15 l) 1-hexyl-3-methylimidazolium dodecyl sulfate;
- m) 1-octyl-3-methylimidazolium butyl sulfate;
- n) 1-octyl-3-methylimidazolium octyl sulfate;
- o) 1-octyl-3-methylimidazolium 2-ethylhexyl sulfate;
- p) 1-octyl-3-methylimidazolium dodecyl sulfate;
- 20 q) 1-decyl-3-methylimidazolium butyl sulfate;
- r) 1-decyl-3-methylimidazolium octyl sulfate;
- s) 1-decyl-3-methylimidazolium 2-ethylhexyl sulfate;
- t) 1-decyl-3-methylimidazolium dodecyl sulfate;
- u) 1-dodecyl-3-methylimidazolium butyl sulfate;
- 25 v) 1-dodecyl-3-methylimidazolium octyl sulfate;
- w) 1-dodecyl-3-methylimidazolium 2-ethylhexyl sulfate;
- x) 1-dodecyl-3-methylimidazolium dodecyl sulfate;
- y) 1-butyl-pyridinium butyl sulfate;
- z) 1-butyl-pyridinium octyl sulfate;
- 30 aa) 1-butyl-pyridinium 2-ethylhexyl sulfate;
- bb) 1-butyl-pyridinium dodecyl sulfate;

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- cc) trimethyldecylammonium butyl sulfate;
- dd) trimethyldecylammonium 2-ethylhexyl sulfate;
- ee) trioctylmethylammonium butyl sulfate;
- ff) trioctylmethylammonium octyl sulfate;
- 5 gg) trioctylmethylammonium 2-ethylhexyl sulfate;
- hh) trioctylmethylammonium dodecyl sulfate;
- ii) trimethyldecylammonium butyl sulfate;
- jj) trimethyldecylammonium octyl sulfate;
- kk) trihexyltetradecylphosphonium butyl sulfate;

10 ll) trihexyltetradecylphosphonium octyl sulfate;
mm) trihexyltetradecylphosphonium 2-ethylhexyl sulfate;
nn) trihexyltetradecylphosphonium dodecyl sulfate; and the ~~method~~ process comprises the
step of: employing the compound as a solvent or, solvent additive, ~~or~~ in a chemical
process; employing the compound as an extraction solvent for a material separation; or
15 employing the compound as a heat carrier, or heat carrier additive in a heat exchange
unit; or employing the compound as a phase transfer catalyst.

17) (Currently Amended) A ~~method process for the use of~~ process for ~~the use of~~ a compound of the Formula 1 ~~in a~~
~~process~~

(cation)(R'SO₄)

Formula 1

20 comprising the step of: employing the compound as a solvent, or solvent additive in a
chemical process; employing the compound as an extraction solvent for a material separation; or
employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit,
wherein:

25 R' is selected from the group consisting of a linear or branched, saturated or unsaturated,
aliphatic or alicyclic, functionalized or non-functionalized alkyl radical with 3-36 carbon atoms,
wherein R' is optionally functionalized with one or more X groups; X is selected from the group
consisting of an -OH, -OR'', -COOH, -COOR'', -NH₂, -SO₄, -F, -Cl, -Br, -I or -CN; and R'' is
30 selected from the group consisting of a branched or linear hydrocarbon chain with 1 - 12 carbon
atoms;

the compound has a melting point of less than 100° C;

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the cation is a nitrogen-containing cation selected from the group consisting of a quaternary ammonium cation, an imidazolium cation, a pyridinium cation, a pyrazolium cation, a phosphonium and a triazolium cation;

the compound of the Formula 1 is substantially hydrolytically stable in neutral aqueous
5 solution (pH = 7) up to 80° C.

18) (Currently Amended) The ~~method~~ process of claim 17, wherein (R'SO₄) has an empirical formula selected from the group consisting of C₄H₉SO₄, C₈H₁₇SO₄ or C₁₂H₂₅SO₄, and; the ~~method~~ process comprises the step of: employing the compound as a solvent, solvent additive
10 ~~, or in a chemical process; employing the compound as an~~ extraction solvent for a material separation; ~~or~~ employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit; or employing the compound as a phase transfer catalyst.

19) (Currently Amended) A ~~method process for the~~ process of using a compound of the Formula 1 ~~in a process~~

(cation)(R'SO₄)
Formula 1

15 comprising the step of: employing the compound as a solvent, or solvent additive in a chemical process; employing the compound as an extraction solvent for a material separation; or employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit, wherein:

- 20 a) (R'SO₄) is an alkyl sulfate ester, wherein the alkyl moiety is selected from the group consisting of butyl, octyl, 2-ethylhexyl, and dodecyl;
- b) the cation is a nitrogen containing cation selected from the group consisting of 1-ethyl-3-methylimidazolium, 1-butyl-3-methylimidazolium butyl, 1-hexyl-3-methylimidazolium, 1-octyl-3-methylimidazolium, 1-decyl-3-methylimidazolium, 1-dodecyl-3-methylimidazolium, 1-butyl-pyridinium, trimethyldecylammonium,
25 trioctylmethylammonium, trimethyldecylammonium, and trihexyltetradecylphosphonium;
- c) the compound has a melting point of less than 100° C; and
- d) the compound of the Formula 1 is substantially hydrolytically stable in neutral aqueous
30 solution (pH = 7) up to 80° C.

20) (Currently Amended) The ~~method~~ process of claim 19, wherein the process is a reaction

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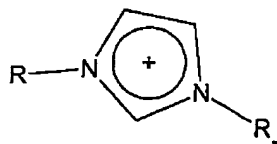
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catalyzed by a transition metal, and the reaction is a hydroformylation reaction, oligomerization reaction, esterification reaction, isomerization reaction or amide bond-forming reaction.

21) (Currently Amended) The ~~method~~ process of claim 19, wherein the process is a reaction catalyzed by an enzyme or biocatalyst, and the reaction is an oligomerization reaction, C-C bond-forming reaction, esterification reaction, isomerization reaction, or amide bond-forming reaction.

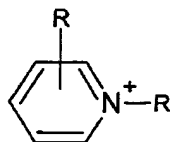
22) (Currently Amended) The ~~method~~ process of claim 18, wherein the cation is selected from the group consisting of:

- a) quaternary ammonium cation with the general formula $(NR_1R_2R_3R)^+$;
- b) phosphonium cation with the general formula $(PR_1R_2R_3R)^+$;
- c) imidazolium cation with the general formula



in which the imidazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group;

- d) pyridinium cation with the general formula



in which the pyridine core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group;

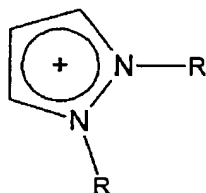
- e) pyrazolium cation with the general formula

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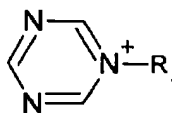
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in which the pyrazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group; and

5 f) triazolium cation with the general formula



in which the triazole core is optionally substituted with at least one group selected from C₁-C₆ alkyl group, C₁-C₆ alkoxy group, C₁-C₆ aminoalkyl group, C₅-C₁₂ aryl group or C₅-C₁₂-aryl-C₁-C₆ alkyl group; wherein

10 g) the radicals R¹, R², R³ are selected independently at each occurrence from the group consisting of:

i) hydrogen;

ii) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

15 iii) heteroaryl groups, heteroaryl-C₁-C₆ alkyl groups with 3 to 8 carbon atoms in the heteroaryl radical and at least one heteroatom selected from N, O and S which is optionally substituted with at least one group selected from C₁-C₆ alkyl groups and/or halogen atoms;

20 iv) aryl, aryl-C₁-C₆ alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C₁-C₆ alkyl group and/or a halogen atom; and

h) the radical R is selected from the group consisting of:

i) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

25 ii) heteroaryl-C₁-C₆ alkyl groups with 3 to 8 carbon atoms in the aryl radical and at least one heteroatom selected from N, O and S, which is optionally substituted with at least

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one C₁-C₆ alkyl group and/or halogen atom; and
iii) aryl-C₁-C₆ alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C₁-C₆ alkyl group and/or halogen atom.

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